Residential Segregation in the Amsterdam Metropolitan Region

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WINDOW ON THE NETHERLANDS

RESIDENTIAL SEGREGATION IN THE AMSTERDAM METROPOLITAN REGION: A LONGITUDINAL ANALYSIS USING SCALABLE INDIVIDUALISED NEIGHBOURHOODS

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ABSTRACT
This paper studies residential segregation in the Amsterdam Metropolitan Area and makes three contributions to the recent debates on segregation. First, both ethnic and socio-economic segregation are studied by comparing isolation index scores for both individual indicators and their interactions. Second, neighbourhoods are defined as scalable individualised units, which allows for comparisons across spatial scales. Third, the paper adopts a longitudinal approach by covering three different time points, which enables us to get a grip on segregation trends. The results indicate that there are notable differences in segregation levels and trends between the applied segregation indicators. Ethnic segregation remained largely stable over the 2003–14 period, whereas the indicators of socio-economic segregation have slightly changed, but all in different directions. Only for tertiary education segregation has increased over the entire period. The Dutch welfare system, the well-dispersed and socially-mixed social housing sector and gentrification help to explain these developments.

Key words: Ethnic segregation; socio-economic segregation; The Netherlands; individualised neighbourhoods; longitudinal analysis; isolation index

INTRODUCTION

The urban diversity debate often focuses on the concentration of migrant groups and people with low socio-economic status in specific neighbourhoods. Given its association with issues of income inequality and large-scale international migration flows, residential segregation has received substantial policy attention (Malmberg *et al.* 2011). The debate surrounding socio-economic and ethnic segregation has been ongoing since Wilson's (1987) study on the largely mono-ethnic ghettos in the large metropolises of the United States. However, Western European studies have found much lower levels of segregation in Europe than in the US (Musterd & van Kempen 2009; Musterd 2011). Nevertheless, the concentration in certain European neighbourhoods of low-income groups, and of ethnic minorities in particular, is regarded as problematic by policy-makers, and is often discussed in the media. It is generally understood that segregation has negative effects on the socio-economic positions and the integration levels of the people who live in such marginalised neighbourhoods (Musterd

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et al. 2003; Lichter *et al.* 2012; Andersson & Malmberg 2015).

Over the past decade, the debate about how segregation should be measured has focused on the role of spatial scale. A number of recent studies have suggested that segregation is continuous across spatial scales, and should ideally be measured in a multiscalar setting (e.g. Clark *et al.* 2015; Jones *et al.* 2015; Fowler 2016). In addition, making reliable comparisons of segregation patterns across different spatial entities and population categories has been difficult due to a lack of comparable data (Musterd & van Kempen 2009), and to differences in administrative ward sizes both across and within countries. This latter challenge has been called the modifiable areal unit problem (MAUP) (Malmberg *et al.* 2011). In order to achieve full comparisons, precisely defined measures that reflect the actual differences in residential patterns between different cities are badly needed (Malmberg *et al.* 2014). Gaining a more thorough understanding of the ethnic[1] and socio-economic segregation patterns at different spatial scales may in turn provide us with insights into the mechanisms related to these processes. It is also essential that we investigate how both socio-economic and ethnic segregation have developed through time. Only by using a longitudinal perspective we will be able to detect patterns that can then be linked to structural factors such as the policy and welfare state contexts and housing market developments.

The main contribution of this paper to the segregation debate is that it provides an analysis on different spatial scales, which makes it easier to compare spatial units in different parts of a metropolitan area by population size. We compare segregation levels at three scales using scalable individualised neighbourhoods within a metropolitan area: a small unit that corresponds with the immediate social environment, a medium-sized scale that corresponds with the neighbourhood, and a large scale generally corresponds with a small town or a borough in a large city. In addition, we compare levels of socio-economic and ethnic segregation, and examine their interaction. These two aspects of segregation are usually studied separately, but are interrelated. We also pay attention to developments through time. Based on Dutch population register data, we compare levels of segregation at three points in time: 2003, 2009 and 2014. The following research question drives our analyses:

> Q1: How have levels and patterns of ethnic and socio-economic segregation at different spatial scales in the Amsterdam Metropolitan Area in the Netherlands developed between 2003 and 2014?

We focus on the Netherlands as a case study for two main reasons. First, the country has a long history of immigration, and is home to a range of large migrant groups that have their own specific migration histories and spatial behaviours (Hartog & Zorlu 2009). Thus, the Netherlands can be seen as an exemplary case for other Western European countries (van Mol & de Valk 2016). Within the Netherlands, we have selected the Amsterdam Metropolitan Area as our research case because in addition to being the largest metropolitan region in the country, its population is both ethnically and socio-economically diverse. Because many new immigrants to the Netherlands initially settle in Amsterdam, it is an interesting urban area case for our study purposes. Second, the availability of rich population register data on the Netherlands allows us to study segregation levels and patterns based on a range of migrant and socio-economic background indicators. Moreover, having access to similar data at different measurement points enables us to investigate the dynamics of segregation.

LITERATURE

Causes of socio-economic and ethnic segregation – Most studies have focused on either socio-economic or ethnic segregation. Generally, the causes of socio-economic segregation are linked to social inequalities, differences in welfare states, and the unequal spatial distribution of social housing (Friedrichs *et al.* 2003; Marcińczak *et al.* 2016).

The degree of segregation is strongly influenced by the type of welfare regime. In market-oriented neoliberal welfare states such as the US, there is a strong relationship between employment, income, education, and quality of housing. In European welfare states, the state intervenes in market processes to reduce

income inequality, and the relationship between employment and residential segregation is weaker (Ostendorf *et al.* 2001; Musterd 2005). While the Dutch welfare system fits nicely within the European tradition, it has moved in recent years towards a more neoliberal policy approach. Yet because of the combined effects of welfare benefits and a progressive income tax system, income differences in the Netherlands are relatively moderate. As a result, the relationship between income and residential segregation is less clear-cut in the Dutch context, and low-income groups do not necessarily live in the poorest segments of the housing market. Nevertheless, there is increasing polarisation between groups based on their employment status. The dominant trends in the labour market are towards professionalisation and upgrading: the educational levels of people who are employed have been rising for a number of years, and the number of jobs at the upper end of the employment structure, especially in the service sector, has grown in both absolute and relative terms. As industrial jobs have been gradually disappearing since the 1970s, labour market opportunities for less educated people have been declining, and people of migrant origin in particular have ended up in disadvantaged positions (Blok *et al.* 2000).

How the housing market is organised also has a strong influence on socio-economic segregation. The allocation procedures and the spatial dispersion of social housing have especially large effects on segregation patterns. The housing policies that influence the distribution of low-income households across cities differ greatly between countries. In Germany, for example, the poorest households depend on social housing, which is allocated by non-profit housing corporations and is predominantly located in peripheral housing estates (Friedrichs *et al.* 2003). The situation is different in the Netherlands, where the social rented sector is relatively large (accounting for 29% of the total housing stock in 2017), and the (family) housing is of high quality, and is well dispersed across the neighbourhoods of cities. Most importantly, the social housing tenant population is relatively diverse in terms of income, and is by no means restricted to the lowest income groups. Social housing is subsidised and is offered by housing corporations for rents that are typically below 600 euro per month. Although units are generally allocated to low-income households, tenants cannot be evicted if their income increases. Especially in cities with a tight housing market, such as Amsterdam, many people continue to live in attractive social rented apartments even though they are no longer part of the target group (Bolt *et al.* 2008; Savini *et al.* 2016). The large size and the diversity of the Dutch social rented sector help to explain why socio-economic segregation levels in Dutch cities are much lower than they are in cities in, for example, the UK (Murie & Musterd 1996) or Belgium (Kesteloot & Cortie 1998), where the social rented sector is smaller and spatially more concentrated.

The literature has shown that ethnic segregation overlaps with socio-economic segregation, but is largely the result of a combination of choices and constraints (Massey & Denton 1988; Musterd & Van Kempen 2009; van Ham & Manley 2009). Different migrant groups have varying opportunities to access both the housing and the labour market (Musterd 2005; Musterd & van Kempen 2009; South *et al.* 2011; Skifter Andersen *et al.* 2016). Examples of constraints that lead to the concentration of migrant groups in certain neighbourhoods are restrictive housing allocation systems and welfare state mechanisms, as well as discrimination (Musterd & van Kempen 2009; van Ham & Manley 2009). However, personal preferences and choices also influence ethnic segregation. The settlement choices of non-Western migrants are often determined not only by neighbourhood economic conditions, but by the presence of co-ethnics, especially in the period immediately after they arrive (Zorlu & Mulder 2008). Thus, if a neighbourhood has historically been home to a specific migrant community, the concentration of that migrant group in the neighbourhood may be reinforced (van Ham & Manley 2009; Zorlu & Latten 2009). For example, van Ham & Clark (2009) found that Pakistani migrants in the UK tend to prefer live in a neighbourhood dominated by co-ethnics, despite having better housing opportunities elsewhere. The results of a recent study on the spatial distribution of non-Western migrants in the Netherlands confirmed that the presence of members of the migrants' own group plays

a large role in neighbourhood selection, but also that there are important differences between various migrant origin groups in how housing choices are made (Boschman & van Ham 2015). Similarly, evidence from the US has shown that ethnic segregation can be reinforced when the native population moves out of ethnic concentration areas (Wilson 1987; South *et al.* 2011). In the European context, some studies have found that natives are especially likely to leave multi-ethnic neighbourhoods (van Ham & Manley 2009; Skifter Andersen *et al.* 2016), whereas others have suggested that natives tend to avoid such areas (Bråmå 2006; Zorlu & Latten 2009). In the Dutch context, most individuals of migrant origin live in neighbourhoods where people from the same country make up less than 10% of the population (Hartog & Zorlu 2009). Neighbourhoods with a high concentration of individuals of migrant origin can either be mixed, with immigrants of diverse origins; or specialised, with a large concentration of one particular immigrant group. The latter type of district is not common in the Netherlands, at least at the level of administrative neighbourhoods. Nonetheless, there are examples of districts where the majority of the population are of non-Western migrant origin. Still, most immigrants in the Netherlands (80%) live in neighbourhoods where people from the same country make up less than 10% of the total population (Hartog & Zorlu 2009). Immigrants tend to be concentrated in the Western part of the country, also called the Randstad region. This region is an urban conurbation consisting of the largest cities in the Western part of the Netherlands – Amsterdam, Rotterdam, The Hague, and Utrecht – as well as a number of medium-sized cities.

Only a limited number of European studies have looked at ethnic and socio-economic segregation simultaneously. The findings of these studies suggest that the segregation of migrant groups often coincides with socio-economic inequalities. Arbaci (2007) found that people of non-Western migrant origin are overrepresented in the poorest neighbourhoods in 16 Western European countries. A study conducted in Athens, Greece showed that specific migrant groups (mainly from non-developed countries) face barriers to integrating into both the labour and the housing market (Kandylis *et al.* 2012). Several studies have found that patterns of segregation in the occupational structure of the migrant population (Marcińczak *et al.* 2012), and the overrepresentation in certain occupations of migrants – and particularly of migrants from less-developed countries – are reflected in their residential patterns (Maloutas 2008; Arapoglou & Sayas 2009). Another study conducted in the Netherlands found overlaps between patterns of segregation among non-Western migrants and concentrations based on average income or dependency on welfare benefits (Hartog & Zorlu 2009). However, in a comparison of both types of segregation for a number of large European cities, Musterd (2005) concluded that class and income patterns only partly explain the levels and patterns of ethnic segregation, and that institutional, historical, and cultural factors also play important roles (Peach 1999; Musterd 2005). A recent study by Musterd and van Gent (2016) that focused on the Amsterdam context found that income and migrant background are complementary, as segregation levels are highest for low-income migrants on the one hand and for high-income natives on the other. Their results also showed that low-income migrants are much more likely to be segregated than middle-income migrants, and that migrants are much more likely to be segregated than natives in the same income groups.

Longitudinal analyses of segregation – Although a range of European studies compared levels of segregation across time, their outcomes differed. In a comparison of levels of ethnic segregation in different European cities, Musterd and van Kempen (2009) found that segregation index scores generally remained stable or decreased over time. However, Tammaru *et al.* (2016) recently found that socio-economic segregation has increased in 13 major European cities, and that in each of these cities, the spatial gap between the poorest and the richest groups has widened. The authors proposed several explanations for this increase. First, they observed, a shift towards the adoption of market-oriented welfare regimes has led to a weakening of the traditional function of welfare state arrangements for redistributing

wealth and reducing social inequalities, which has in turn resulted in higher levels of social inequality and segregation. Second, they noted that the social and the physical upgrading of neighbourhoods have shaped social segregation, largely through processes of gentrification and displacement. Finally, they pointed out, national or local housing market policies, as well as the composition of local housing, may have affected the spatial distribution of socio-economic groups across space (Marcińczak *et al.* 2016; Tammaru *et al.* 2016).

A number of longitudinal studies have paid specific attention to the Dutch context. Most of these studies focused on ethnic segregation, (one of) the four largest cities in the Netherlands (Amsterdam, Rotterdam, The Hague, and Utrecht), and the four main non-Western migrant communities (Turks, Moroccans, Surinamese, and Antilleans). These studies generally reported that levels of segregation have been relatively stable, but that since the 1990s, concentrations of migrants have been gradually shifting away from inner-city districts and towards post-war neighbourhoods (Bolt *et al.* 2002). Other studies have emphasised that trends in ethnic segregation levels are both group- and city-specific. For example, Musterd and Ostendorf (2009) found that levels of segregation for Moroccan and Turkish migrants and their descendants have been increasing in Amsterdam, but have been decreasing in Rotterdam and The Hague; whereas levels of segregation for Surinamese migrants have been declining in general, and levels of segregation for Antilleans have hardly changed at all over time. Still other studies on the residential patterns of ethnic groups found a tendency among Turkish and Moroccan origin groups to leave existing concentration areas (Musterd & de Vos 2007) and to settle in areas with lower concentrations (Bolt *et al.* 2008). Since 2000, Surinamese and Antillean migrants have been gradually moving into suburban districts, but new concentration areas have also been developing in these districts (Musterd & Ostendorf 2009). The stability in the segregation patterns of migrant groups may be explained by migrants' preferences to live near members of their ethnic social networks. Zorlu and Mulder (2010) studied the residential patterns of nest-leavers, and found that compared to their native Dutch counterparts, nest-leavers with a non-Western migrant background are more likely to move to neighbourhoods with a high proportion of residents with a non-Western background. According to the authors, differences in the socio-economic characteristics of the nest-leavers, their parents, or their origin neighbourhoods explain only a portion of these differences. Thus, they concluded, the proximity of ethnic social networks likely plays an important role in migrants' housing choices. The findings of a recent study on socio-economic segregation in Amsterdam indicated that the levels of segregation of the highest-income strata and low-income migrants have increased since 2004, or at least until the start of the economic crisis (Musterd & van Gent 2016).

Segregation levels and the issue of scale – The existing studies on residential segregation have mainly analysed administrative or statistical units, such as census tracts, and, in the Dutch case, neighbourhoods (*buurten*) that are defined by municipalities. Although most previous research on ethnic and socio-economic segregation focused on a single spatial scale, some recent studies have called for the use of multiscalar approaches in the measurement of segregation. Johnston *et al.* (2016) adopted multiscalar measures to construct a typology of British census tracts according to their ethnic mix: that is, the share of non-Whites to Whites. Their results suggest that the degree of clustering into neighbourhoods where Whites are a minority is higher if the non-White component in an urban area's population is larger. In general, they found an increase in shared residential spaces at the neighbourhood level. Fowler (2016) has asserted that segregation is continuous across different scale levels, and that there is no single 'correct' scale for measuring it. Likewise, Jones *et al.* (2015) argued that scale is important for understanding the causes and impact of segregation. In their study, they found that the strongest concentrations of most (though not all) ethnic groups are at both the largest and the smallest scales. Specifically, they showed that ethnic groups are clustered into specific boroughs, and into several small areas within them. Similar conclusions were drawn

by Manley *et al.* (2015), who studied patterns of ethnic segregation in New Zealand at three spatial scales: the macro scale (localities), the meso scale (area units), and the micro scale (mesh-blocks). The authors found evidence that segregation is strongest at the macro scale, but that the largest decreases are at the micro scale. They also found that segregation might be highly localised for some groups: that is, within each macro-scale locality of a city, a group can be relatively evenly distributed across its meso-scale areas, but highly concentrated in certain micro-scale mesh-blocks in at least some of those areas.

Clark *et al.* (2015) argued that multiscalar measures can be used to better understand neighbourhood dynamics because they show the links between the actual changes in patterns of segregation and the experiences of changing population compositions in the residential locations of individuals. Geocoded individual data offer opportunities for solving boundary and scale issues through the construction of scalable 'individualised neighbourhoods'. Each of these 'egocentric' districts can be seen as a buffer drawn around a specific spot that is defined by a predefined distance radius (Reardon *et al.* 2008) or a k-number of nearest neighbours (k-levels) (Östh 2014). All of the people who live within this buffer form an individualised neighbourhood (Clark *et al.* 2015). Each method of measuring individualised neighbourhoods has its advantages and disadvantages. When drawing buffers based on distance, there is less variation in the geographical distance between 'neighbourhood residents', but the number of residents may vary widely. The use of a k-nearest neighbour approach results in units that are more comparable in terms of population size, but the geographical distance between neighbours may vary more, especially in less urbanised regions. Several studies published over the past year have investigated residential segregation and its related contextual effects by comparing individualised neighbourhoods of different sizes. A study by Petrović *et al.* (2018) that examined a wide range of bespoke neighbourhoods based on distance found both more variation and greater complexity in the spatial patterns of ethnic exposure. Andersson and Malmberg (2015) investigated neighbourhood effects on educational attainment using multiple units with fixed population sizes. They found that neighbourhood effects are stronger at spatial scales that are much smaller than administrative units. A recent study by Andersson *et al.* (2018), also using the k-nearest neighbour approach, showed variation in ethnic concentrations across different spatial scales.

DATA AND METHODOLOGY

Data – We use population register data from Statistics Netherlands for the years 2003, 2009 and 2014 providing a long term view and covering both the period before, at and after the economic downturn of 2008. The System of Social Statistical Datasets (SSD) of Statistics Netherlands is a system of linked statistical registers and surveys that cover a broad range of demographic and socio-economic subjects in which data from various sources, such as municipal population registers, tax offices, labour offices, and public education institutes, are combined (Bakker *et al.* 2014). These data contain detailed information on individuals' personal characteristics (age, gender, origin, household situation), socio-economic characteristics (educational level and income sources, including both employment and welfare benefits), and place of residence. For each individual, the SSD provides information on his or her addresses, although the actual addresses are replaced by a unique numeric code for privacy reasons. Each address is then linked to a unique combination of geo-co-ordinates: an x-co-ordinate indicating the location on a line running from east to west, and a y-co-ordinate indicating the location on a line running from north to south. The co-ordinates for the Netherlands are based on the *Rijksdriehoeksstelsel*' (RD), which is compatible with the European Terrestrial Reference System 1989 (ETRS89), and is maintained by the national cadastre. These co-ordinates are the input for the measurement of individualised neighbourhoods, which allow for comparisons of segregation levels across different spatial scales.

Multiscalar and longitudinal approach – This study adopts a multiscalar and longitudinal approach for measuring both ethnic and socio-economic segregation. We construct individualised neighbourhoods based on a k-number of nearest neighbours (k-levels). All individual addresses are grouped into grids of 100 by 100 metres. These grids are the starting point of our analysis. From each 100-by-100-metre grid, the Swedish geographical information system *EquiPop* (see Östh 2014 for a detailed description) can find nearest neighbours in the adjacent grids based on the geocoded information. From each grid, EquiPop starts looking for a k-number of nearest neighbours in the adjacent grid cells, and does this exactly the same way from each grid cell. If, for example, EquiPop is looking for 200 nearest neighbours, it stops looking for nearest neighbours after reaching the grid cell in which the 200th person is found, but it includes all people living in that final grid. The number of grids needed to reach the k-number of nearest neighbours depends, of course, on the population density of the region under study; in densely populated areas such as the Amsterdam Metropolitan Area, fewer grids will be needed to reach the same number of neighbours than in rural areas with lower population density. In this paper, we use three k-levels (scales), with small (200), medium-sized (6,400), and large (51,200) population counts. In the context of the Amsterdam Metropolitan Area, the small units are the direct social surroundings of an individual, while the medium-sized units are the size of administrative neighbourhoods, and the large units are similar in size to boroughs.

The first part of the analysis consists of a comparison of scores on the isolation index for four indicators of segregation. The first indicator refers to the ethnic component of segregation: the ratio of people of non-EU foreign origin within the total population of each individualised neighbourhood. The people of non-EU foreign origin include individuals born abroad in a country other than the EU and EFTA countries (first-generation migrants), as well as their descendants (second-generation migrants). For the first generation, the individual's own country of birth determines whether the person is of non-EU foreign origin; while for the second generation born in the Netherlands, the mother's country of birth determines whether the individual is of non-EU foreign origin.[2]

The isolation index is the most common measure of 'exposure': the degree of potential exposure of individuals to members of their own group (Massey & Denton 1988; Nijkamp & Poot 2015). The isolation index is measured for a city or, as in this case, a metropolitan region, and is the sum of all scores for all its individual districts. In a situation with fixed boundaries, the following formula is used:

$$SpatialIsolation = \sum_{i=0}^{n} \left[\left(\frac{x_i}{X} \right) \left(\frac{x_i}{t_i} \right) \right].$$

In this formula, x_i is the minority population of area i, X is the total minority population, and t_i is the total population of area i (Iceland *et al.* 2000). The index ranges from one, which signifies that a minority member will likely encounter co-ethnics within a given area only, to zero, which signifies that this chance is absent (Malmberg *et al.* 2011). Three other neighbourhood aspects are related to the socio-economic component of segregation: the ratio of employed people aged 30–59 (salaried employees, independent entrepreneurs, directors or CEOs, or otherwise employed), the ratio of people at risk of poverty (measured as an income below 60% of the median income), and the ratio of people with tertiary education (at least higher vocational or university training) aged 25–65 within each individualised neighbourhood. These index scores will be calculated at all three scale levels (200, 6,400, and 51,200 nearest neighbours) and for three years (2003, 2009 and 2014).

While the abovementioned formula is useful for administrative districts (in which the sum of all districts (t_i) equals the total population (X)), it is not useful for the non-static individualised neighbourhoods studied in this paper. In individualised districts, the same people may be counted as nearest neighbours several times, which means that the sum of all individualised neighbourhoods does not

equal the total population of a metropolitan area. Therefore, a weighted average for the minority population in each grid cell is used, leading to the following formula:

$$SpatialIsolation_k = \sum_{i=1}^{n} \frac{\left(x_i * \frac{x_{i,k}}{k}\right)}{\left(x_i\right)}.$$

In this formula, x_i stands for the size of the local minority population in each grid cell, whereas $\frac{x_{i,k}}{k}$ represents the share of this minority group within the total population of each k-level.

We first calculated the isolation index scores for each indicator separately. In a next step, we looked at the interaction between ethnic and socio-economic segregation by studying the segregation levels of people of non-EU origin with low socio-economic status. For this step, we first calculated the interaction between non-EU origin and being at risk of poverty. The second interaction was between 'non-EU' and 'unemployed'. We then created maps illustrating the segregation patterns in 2003, 2009 and 2014.

Research area – Our paper focuses on the Amsterdam Metropolitan Area, which is the largest city region in the Netherlands. The city of Amsterdam had 810,935 inhabitants in 2011, and is the capital and the main financial hub of the Netherlands. The entire metropolitan area has approximately 2.3 million inhabitants. Amsterdam is a highly diverse city with an ethnically mixed and socio-economically diverse population. In 2017, members of 167 nationalities were living in Amsterdam, and all of the four largest non-Western migrant origin groups in the Netherlands are well represented in the region (OIS 2017). The Amsterdam region has a diverse economic profile that is dominated by business and financial services, logistics, and cultural industries. This diverse economy has made the region attractive for both high- and low-skilled workers (Burgers & Musterd 2002; Sleutjes 2016).

RESULTS

Isolation index – The isolation index is a measure of exposure indicating the chance that an individual will encounter only members of his or her own origin or socio-economic group during a random walk through a certain locality. This measure provides a good approximation of ethnic or socio-economic segregation, and comparing index scores for different years makes it possible to study trends over time. Figure 1 shows the development of the isolation index scores for all four indicators for the years 2003, 2009 and 2014. We should note that the index scores were rather modest for all four indicators. The highest scores we found were around 0.4, which on a scale from zero to one does not indicate a very high degree of segregation. Nevertheless, the scores were somewhat higher for the indicators 'non-EU origin' and 'employed' than for 'tertiary education' and 'risk of poverty'.

The isolation index scores remained relatively stable over the study period. The changes in the index scores over time were very small in general, but the four indicators did show some differences in the direction of these developments. For 'non-EU origin', the index scores were almost the same at the three different time points, which suggests that ethnic segregation remained stable between 2003 and 2014. For 'risk of poverty', we find that the isolation index at all three spatial scales remained stable between 2003 and 2009, but decreased slightly between 2009 and 2014. Although a decrease of approximately 0.05 is too modest to indicate a significant decline in the residential segregation of low-income groups in the Amsterdam Metropolitan Area, it does suggest the situation has, at least, not worsened. For 'tertiary education', we see the opposite picture, as there was a slight increase in segregation scores. The index scores were lowest in 2003 and highest in 2014, but remained between 0.1 and 0.2. This finding suggests that despite the small increase in segregation, the highly-educated were quite well-dispersed across the different units within the region over the entire period. Finally, for the indicator 'employed', we find that a slight increase in the index scores between 2003 and 2009 was followed by a slight decrease between 2009 and 2014. Thus, although the year-by-year differences in the scores were relatively small, the spatial concentration of people who were

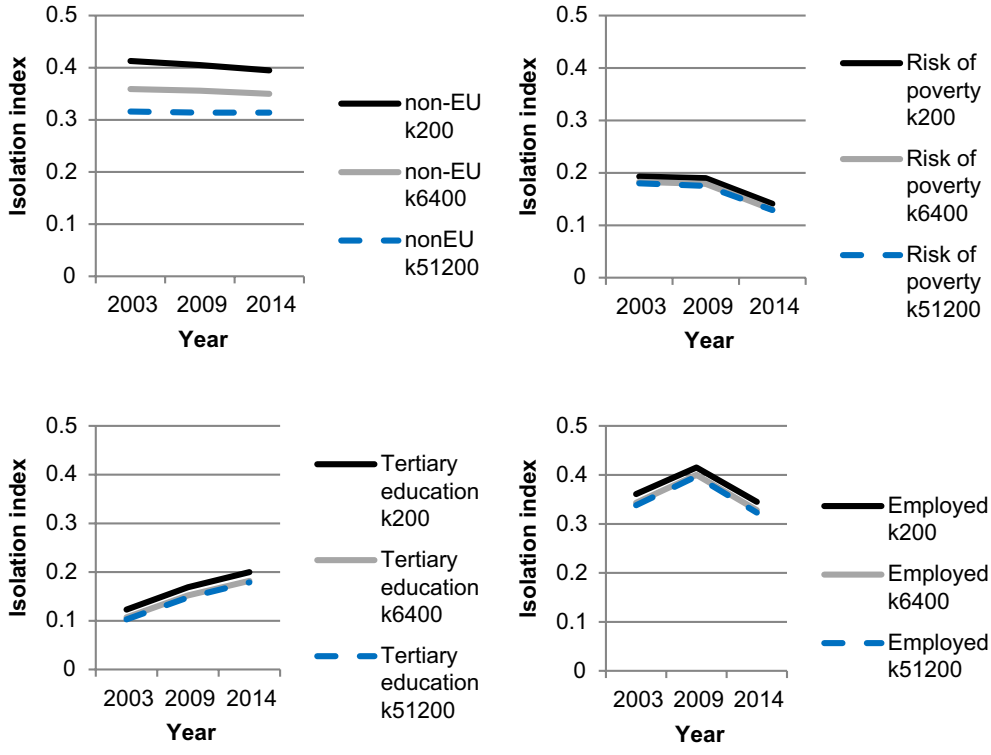

Figure 1. *The development of isolation index scores at three spatial scales (k200, k6,400, and k51,200) across time for 'non-EU', 'risk of poverty', 'tertiary education', and 'employed'. [Colour figure can be viewed at wileyonlinelibrary.com]*

aged 30–59 and in active employment initially became stronger, and subsequently became weaker. This trend could be explained by the financial crisis, which caused unemployment levels to rise starting in 2009.

When we look at the differences in the isolation index scores and their longitudinal development across spatial scales, we see that regardless of the indicator, levels of segregation were highest at the smallest scale (k200) and were lowest at the largest scale (k51,200). This pattern also held across all three time points. However, the differences between the three scales were larger for the 'non-EU origin' indicator than for the three socio-economic indicators, for which the differences between the three scales were minimal. For people of non-EU origin, we find that segregation levels decreased slightly if the spatial scale was enlarged: that is, the levels were around 0.40 at the smallest spatial scale, around 0.36 at k = 6,400, and around 0.31 at the largest spatial scale.

In Figure 2, we show the outcomes for the interactions between ethnic and socio-economic segregation. We see that the segregation levels for people who were of non-EU origin and were at risk of poverty were lower than they were for people of non-EU origin and for people at risk of poverty in general. The index scores were around 0.1 at all scales, and this pattern remained largely stable across time. When we compare the development of isolation index scores across time, we find that the segregation levels for the interaction variable 'non-EU × risk of poverty' increased minimally, whereas the levels of segregation for the two indicators separately decreased slightly over the same period. The differences across spatial scales were minimal. But again, the highest index scores were at the smallest scale and the lowest scores were at the largest scale.

The second interaction was between 'non-EU' and 'unemployed'. The resulting

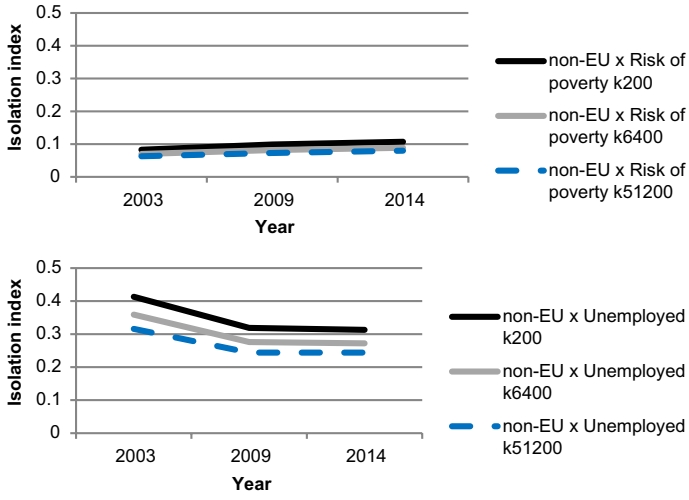

Figure 2. *The development of isolation index scores at three spatial scales (k200, k6,400 and k51,200) across time for the interaction between 'non-EU' and 'risk of poverty' and the interaction between 'non-EU' and 'unemployed'. [Colour figure can be viewed at wileyonlinelibrary.com]*

isolation index scores are illustrated by the lower graph in Figure 2. In 2003, the segregation levels for this group at all scales were comparable to those for 'non-EU' in general. However, we see a small decrease in segregation levels between 2003 and 2009, followed by a pattern of stability between 2009 and 2014. At the end of the period, segregation levels for the interaction 'non-EU × unemployed' were somewhat lower than those for 'non-EU' in general. The differences across the spatial scales were comparable to those for 'non-EU' in general. For this interaction as well, segregation became somewhat weaker with each increase in spatial scale.

Cartographic illustration – The only indicators for which we find an increase in segregation – albeit a small one – is tertiary education. This slight increase is also illustrated by a cartographic example. The maps in Figures 3 and 4[3] show the segregation of highly educated people in the Amsterdam Metropolitan Area. We focus on one spatial scale, k = 200, since developments across the different scales were similar for all indicators, and k = 200 is the scale at which the isolation index scores were highest for all indicators and for both years.

Both maps show that people with tertiary education were mainly clustered in the central areas of the core city: that is, in the inner city and the surrounding belt of nineteenth century neighbourhoods. This pattern remained stable across the 12-year period. Over time, however, more areas shifted into the two dark blue categories with population shares of 37.5-50 per cent and of more than 50 per cent, respectively. We can also observe that in the central parts of the second urban centre in the region, Haarlem, the share of the population who were highly educated increased between 2003 and 2014. This finding suggests that while roughly the same areas continued to be the main clusters for the highly educated, the relative shares of this group within the total populations of these units grew over time. Moreover, the concentration of the highly educated in the non-concentration areas remained largely stable over the same period, which indicates an increase in the level of segregation.

The indicator that changed the least over the study period was the only indicator of ethnic segregation: namely, the share of people of non-EU origin. The maps in Figures 5 and 6[4] also suggest that this indicator remained stable. Generally, we see that the

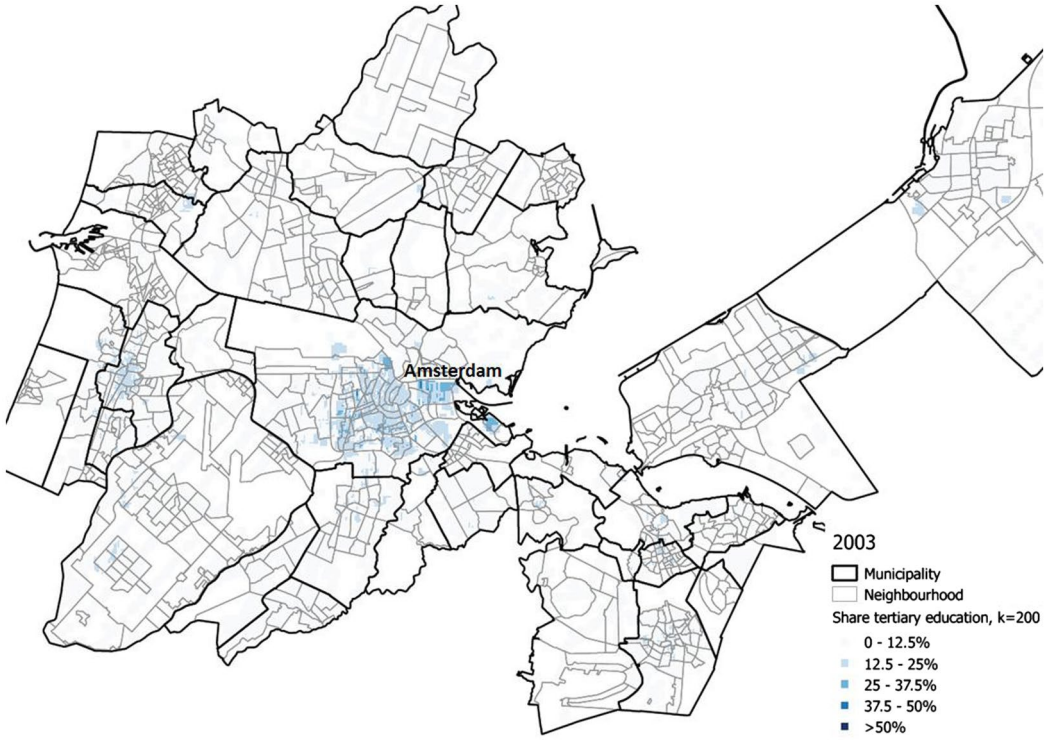

Figure 3. *The share of people with tertiary education across individualised neighbourhoods (k = 200) in the Amsterdam Metropolitan Area in 2003. © 2003, Centraal Bureau voor de Statistiek/Topografische Dienst Kadaster. [Colour figure can be viewed at wileyonlinelibrary.com]*

strongest concentration areas for this group were mainly in two boroughs on the urban fringes of the city of Amsterdam: Nieuw-West at the far west end of the city and Zuidoost at the south-eastern edge of the city. The housing in these areas consists mainly of high-rise blocks and other post-war buildings that are primarily inhabited by lower socio-economic status groups, including many families of non-Western foreign origin (Dekker & van Kempen 2004). But within these boroughs, we find that in some parts of a given neighbourhood there were very specific concentrations, while in other parts of the same neighbourhood the segregation scores were lower. We also observe that in the central part of the city, only the districts located on the east side of the city centre (Zeeburg) had relatively high concentrations. Other areas that we identified as having relatively high concentrations of people of non-EU foreign origin over the entire period are parts of the northern borough Amsterdam-Noord, as well as some districts in the neighbouring cities of Zaandam (Poelenburg) and Haarlem (Schalkwijk).

When we compare Figures 5 and 6, we see that the main concentration areas in 2003 were still the main concentration areas in 2014, with the exception of a few locations on industrial or commercial sites that were presumably used as temporary accommodation for refugees. We do not see a clear increase in the number of concentration areas, or in the share of non-EU residents in the total population of these districts. The maps also indicate that the levels of segregation of people of non-EU origin were indeed higher than they were for people in all three socio-economic categories. At the smallest spatial scale, the share of people of non-EU origin in the local population exceeded 80 per cent in some places – which was much higher than the largest share for each socio-economic indicator (between 50% and 60%). This pattern can be

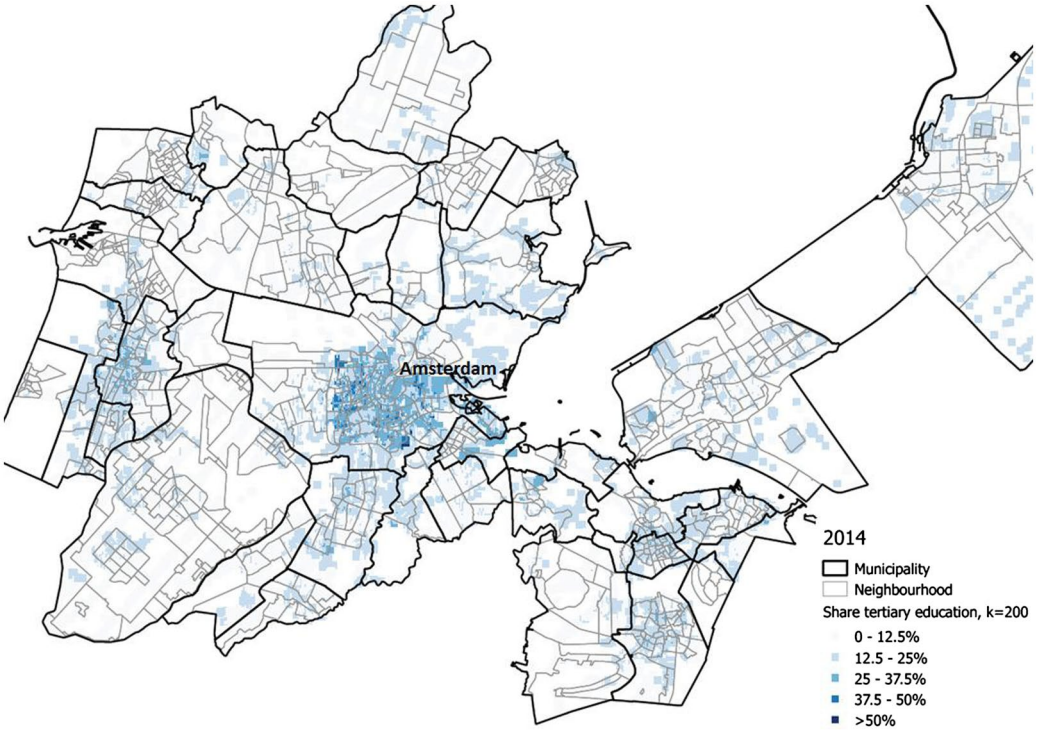

Figure 4. *The share of people with tertiary education across individualised neighbourhoods (k = 200) in the Amsterdam Metropolitan Area in 2014. © Kadaster/Centraal Bureau voor de Statistiek, 2016. [Colour figure can be viewed at wileyonlinelibrary.com]*

observed in a selected number of small pockets within administrative neighbourhoods. We do not, however, see a large increase in the number of units with such high shares, or an increase in the size of these shares over time.

Another notable finding is that non-EU migrants were underrepresented in the main clusters for tertiary education, and vice versa. Thus, these maps present a more or less mirror image of the maps for tertiary education.

CONCLUSIONS AND DISCUSSION

In this paper, we presented a descriptive analysis of ethnic and socio-economic segregation in the largest metropolitan region of the Netherlands. Our analysis built upon the recent literature on segregation as a multiscalar phenomenon by measuring segregation levels at three spatial scales, and at three points in time. The methods we applied made the population sizes of the spatial units in different parts of a metropolitan region more comparable.

Our main conclusion is that both the ethnic and the socio-economic segregation levels in the Amsterdam Metropolitan Area remained largely stable at all spatial scales across the years 2003, 2009 and 2014. The isolation index scores for the share of non-EU residents showed only minimal variation across the three years. The index scores for the three indicators of socio-economic segregation were as follows: a modest decrease in the share of people at risk of poverty, a modest increase in the share of people with tertiary education, and an inverted U-shape for the share of employed people. Our findings also show that the segregation levels in the Amsterdam Metropolitan Area were relatively modest, as at each spatial scale and for each indicator, the isolation index scores were below

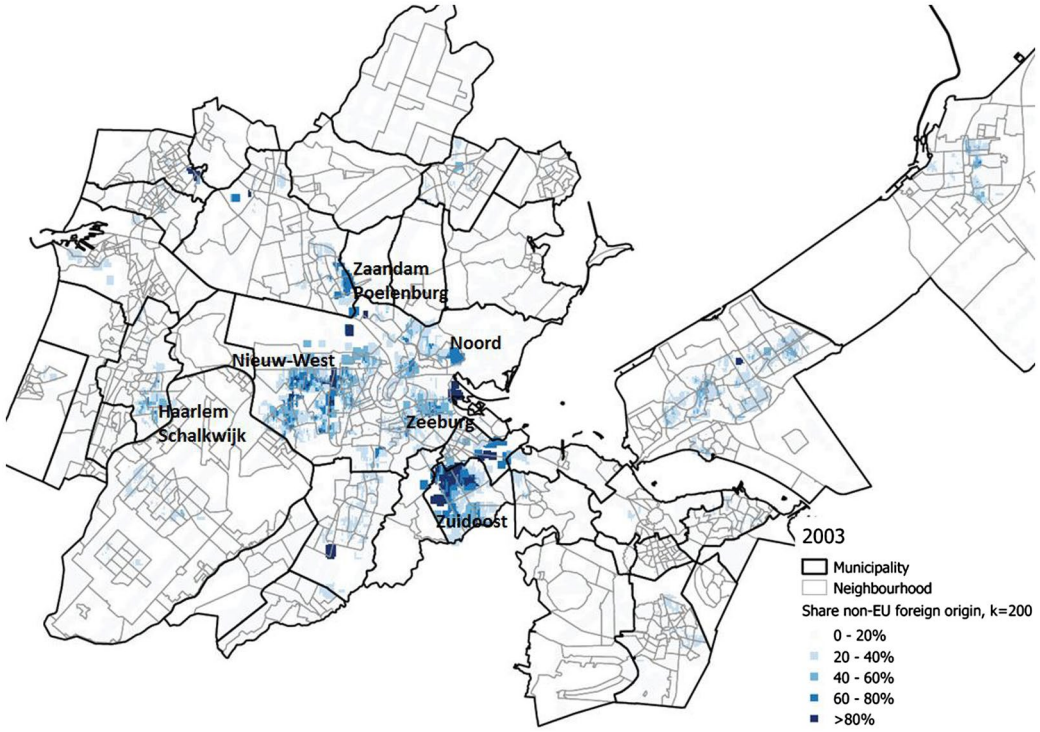

Figure 5. *The share of people of non-EU foreign origin across individualised neighbourhoods (k = 200) in the Amsterdam Metropolitan Area in 2003. © 2003, Centraal Bureau voor de Statistiek/Topografische Dienst Kadaster. [Colour figure can be viewed at wileyonlinelibrary.com]*

0.4. Nevertheless, the segregation levels were slightly higher for the indicators 'non-EU' and 'employed' than for the indicators 'tertiary education' and 'risk of poverty'. The maps for people of non-EU foreign origin clearly show that in the Amsterdam Metropolitan Area, this group was indeed overrepresented in certain neighbourhoods, exceeding 80 per cent in some small sections.

When we consider these two interactions between the ethnic and the socio-economic indicators, we cannot conclude that people of non-EU origin with low socio-economic status were more segregated than people of non-EU origin in general. Rather, compared to the stable and moderate segregation levels we observed among non-EU migrants and their descendants in general, we found a lower (albeit a slightly increasing) level of segregation among people with a low income, and a similar but decreasing level of segregation among people who were unemployed. However, as another recent study found the highest segregation levels for low-income migrants (Musterd & van Gent 2016), it appears that the definitions of migrants and of poverty that are used are crucial. In our study, data limitations (resulting from the international data comparability that was achieved in the project Residential segregation in five European countries/ResSegr) meant that we were bound by a distinction between migrants of EU and non-EU origin. Yet within these groups, there are obviously people with a wide range of origins, migration backgrounds, and reasons for migrating that we cannot capture with this rather simplified measure. Although our analyses have uncovered interesting patterns, potential differences between origin groups may be masked because of the dichotomy applied here. However, as a report by the *Wetenschappelijke Raad voor het Regeringsbeleid* (The Netherlands Scientific Council for Government Policy) recently noted, any grouping of migrants by origin can

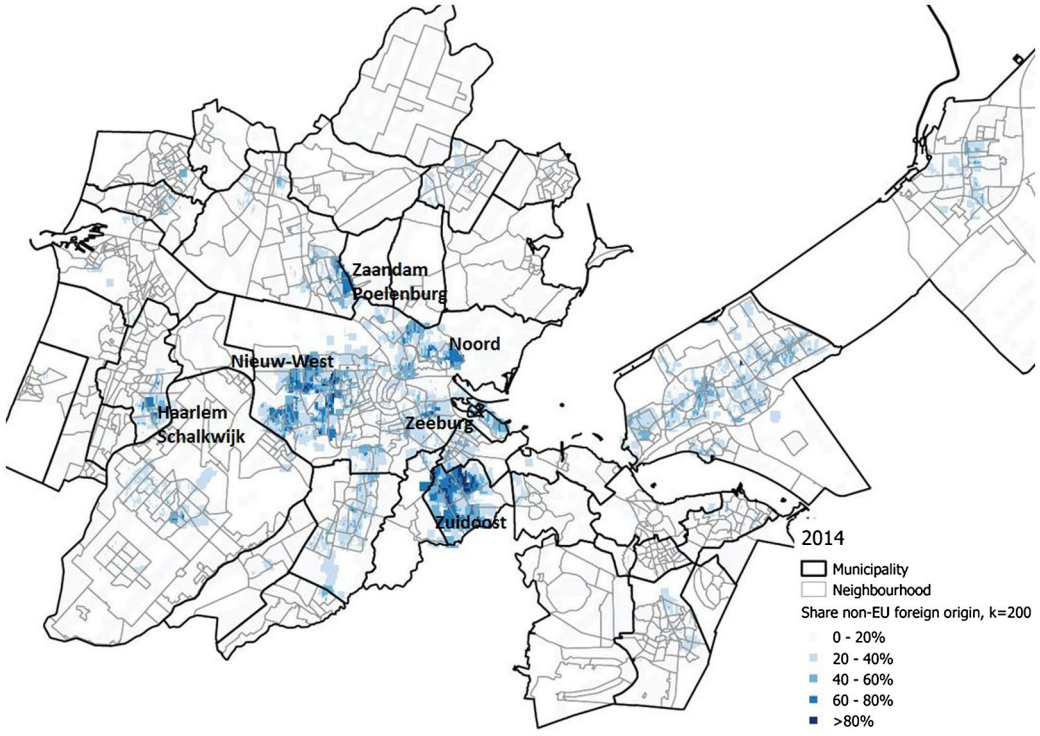

Figure 6. *The share of people of non-EU foreign origin across individualised neighbourhoods (k = 200) in the Amsterdam Metropolitan Area in 2014. © Kadaster/Centraal Bureau voor de Statistiek, 2016. [Colour figure can be viewed at wileyonlinelibrary.com]*

be seen as arbitrary and problematic in the context of a highly diverse population (Jennissen *et al.* 2018). This implies that future studies on segregation should thoroughly re-examine how the origins of migrant groups are measured, especially when comparing cities or countries.

Looking at the spatial scale, we found for all four indicators and for the two interactions that the segregation index scores in each year were highest at the smallest scale (k200), and decreased slightly with each enlargement of scale. The differences across the spatial scales were shown to be largest for the 'non-EU' indicator and for the interaction 'non-EU × unemployed'. This result suggests that ethnic segregation is most easily observed at the micro-scale level. This finding is also confirmed by the maps for non-EU migrants, which show very large shares for this group in the total population at the smallest scale. For the three socio-economic indicators, the differences across the spatial scales were found to be smaller.

The isolation index scores thus suggest that over the study period, the Amsterdam Metropolitan Area did not display the high levels of ethnic and socio-economic segregation that have been reported for the US (Wilson 1987) or France (Wacquant 1993). While the cartographic analysis indicated that there were pockets within specific neighbourhoods in which more than half of the local population was made up of a specific group, these small-scale units were few in number.

The relatively modest scores for socio-economic segregation and the small changes over time are in line with the results of previous studies on this topic for Amsterdam. Musterd and van Gent (2016) found that Amsterdam has not acknowledged that levels of socio-economic segregation have been increasing in the city since the 2000s. Our finding that levels of segregation in Amsterdam have been consistently low can be explained by two structural factors. First, the Dutch welfare

state system has a long-standing focus on reducing income inequalities through welfare benefits and a progressive tax system (Blok *et al.* 2000). Second, the Dutch housing market has a relatively large social rented sector that is used by middle as well as lower-income groups. Moreover, in contrast to the social housing estates in other European countries, social housing in the Netherlands is relatively evenly dispersed across cities (Friedrichs *et al.* 2003), and is less stigmatised. Because of the role social housing plays in the Netherlands, the link between people's incomes and their housing conditions is weak in the country in general, and especially in Amsterdam, where 67 per cent of all housing is subsidised (Savini *et al.* 2016).

An additional explanation for our findings is that in recent decades, Amsterdam has been undergoing a process of gentrification that has been growing in intensity, and has been stimulated in part by the city's urban development policies. Since the 1980s, Amsterdam's centrally located neighbourhoods have gradually changed from being predominantly working-class neighbourhoods to being mixed-income districts that also increasingly attract and retain middle-income families with children (Boterman 2013; Savini *et al.* 2016). Because Amsterdam is the national hub for financial and business services and for large multinational companies, the city has become increasingly attractive to highly-skilled expats whose residential preferences are largely in line with those of highly-skilled Dutch natives (Sleutjes & Boterman 2016). Although this transition initially resulted in the city having a relatively equal mix of income groups, the debate about gentrification in Amsterdam is increasingly concerned with skyrocketing housing prices in the central areas of the city that have caused the displacement of lower socio-economic groups (including many people with a migrant background) and fewer opportunities for low-income people to find housing in these areas. The increasing share of people with tertiary education in the central parts of the city can be seen as a sign of the gentrification trend. This (planned) gentrification process is expected to further exacerbate the spatial divide between the central and the peripheral parts of the city (Hochstenbach & van Gent 2015; Savini *et al.* 2016), and has already changed the relationship between Amsterdam and its surrounding region. As people with lower income levels or migrant backgrounds have been moving to the surrounding region at the same time as people with higher levels of income and education have been moving to the city, the traditional spatial division – that is, the understanding that the city was primarily a place for low-income groups and migrants to live while suburban areas provided housing for middle and high-income groups – has vanished (Musterd & van Gent 2016). This pattern of movement may therefore help to explain why the level of income segregation at the regional level is currently relatively modest.

When we looked at segregation by socio-economic group, we found that levels of segregation varied the most depending on whether people were employed or unemployed. A potential explanation for this finding is that the labour market in the Netherlands has shifted towards higher-skilled jobs and away from lower-skilled work, especially in the Amsterdam Metropolitan Area, where the labour market is dominated by business services (Burgers & Musterd 2002; Sleutjes 2016). Meanwhile, a possible explanation for our finding that levels of segregation were higher for the non-EU foreign origin indicator than for the socio-economic indicators is that ethnic segregation is influenced not only by socio-economic factors and the availability of housing, but by personal residential preferences that are often related to the long-standing presence of ethnic communities in certain neighbourhoods (Zorlu & Mulder 2008; Zorlu & Latten 2009). These factors may explain why we found nearly the same concentration areas with comparable population shares across the three years studied. With the exception of areas in the central-Eastern districts, these areas were mainly located in peripheral districts where housing was relatively cheap. But given that the process of gentrification has been intensifying in these districts, the question of whether these concentrations will change in the next few years remains open.

Although our study provides new longitudinal insights into segregation in Amsterdam, it also has a number of drawbacks in terms of the methods and specifications used. First,

the method EquiPop uses to construct individualised neighbourhoods by taking a predetermined 'route' through adjacent grids to find the nearest neighbours is consistent but it is also arbitrary. Taking another 'route' by, for example, starting in the Southern adjacent grid rather than in the Northern grid may result in a different neighbourhood composition. Future studies may be able to improve the software to address this issue. Second, although focusing on a fixed number of nearest neighbours ensures that the units under study are comparable in terms of population size, the distances between these neighbours may vary between grids, which could hamper comparisons between sides. However, we believe that in a densely populated area such as the Amsterdam Metropolitan Area, this variation would not affect our findings substantially. Third, as we noted above, the categorisation of migrants (EU versus non-EU foreign origin) we used is rather arbitrary, and includes a large variety of migrant origin groups who have different migration histories and backgrounds. However, we doubt that using a different typology (such as Western versus non-Western) would have led to very different outcomes. More in-depth analyses of different individual groups of origin would provide more insight into the processes at this micro level, and would complement our analyses. Finally, examining segregation at different points in time does not necessarily imply that the same population is being studied, as new migrants may have arrived and others may have left the city between these years. However, our findings indicate that in the case of Amsterdam, the patterns did not change much from year to year. Nevertheless, it would be interesting for future studies to further link internal mobility and international migration to patterns of segregation.

Moreover, even though our analyses showed that the level of segregation in Amsterdam is relatively modest and stable, future work should build on our findings to provide more insight into the processes of segregation among different migrant origin groups, as well as among different cities and regions in the Netherlands and beyond. The method we applied in this study allows us to make more accurate comparisons across different locations, and thus provides us with the opportunity to advance our academic knowledge on segregation processes, as well as on potential policy responses.

Notes

1. We refer to ethnic segregation throughout the paper as it is commonly defined in the literature. However, our data analyses do not identify ethnic origin or ethnicity as such. The Dutch population registers that we use here define a person as a migrant based on his or her country of birth and that of both of his or her parents. It is important to note that this definition is not necessarily equivalent to ethnicity.
2. In the paper, we distinguish between the migrant populations with an EU and with a non-EU background. We are aware that this is a simplification of the diverse origins of migrants. Although details on the individual origins of migrants are potentially available from the register data, they are not publicly available at the level of detail and in combination with the information on other characteristics we require for our study. Moreover, the work presented here is part of an international collaborative project in which the goal was to retrieve similar data from population registers in five European countries. This process resulted in a distinction being made between EU and non-EU migrants within the framework of the project. We also believe that it is the most meaningful way to differentiate between the countries studied. See project website https://www.residentialsegregation.org/.
3. See Appendix 1 for the full set of maps on all three years.
4. See Appendix 1 for the full set of maps on all three years.

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